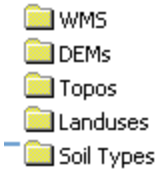
Workflow for Using WMS to Compute Curve Numbers & For Using TR-55 and NFF Regression Equations in WMS

Created by Kirk Thornock

This workflow is intended to give the Designers and Design Techs a step-by-step method to successfully use WMS to compute Curve Numbers for TR-55 application, and to use WMS to compute flow using NFF Regression Equations.

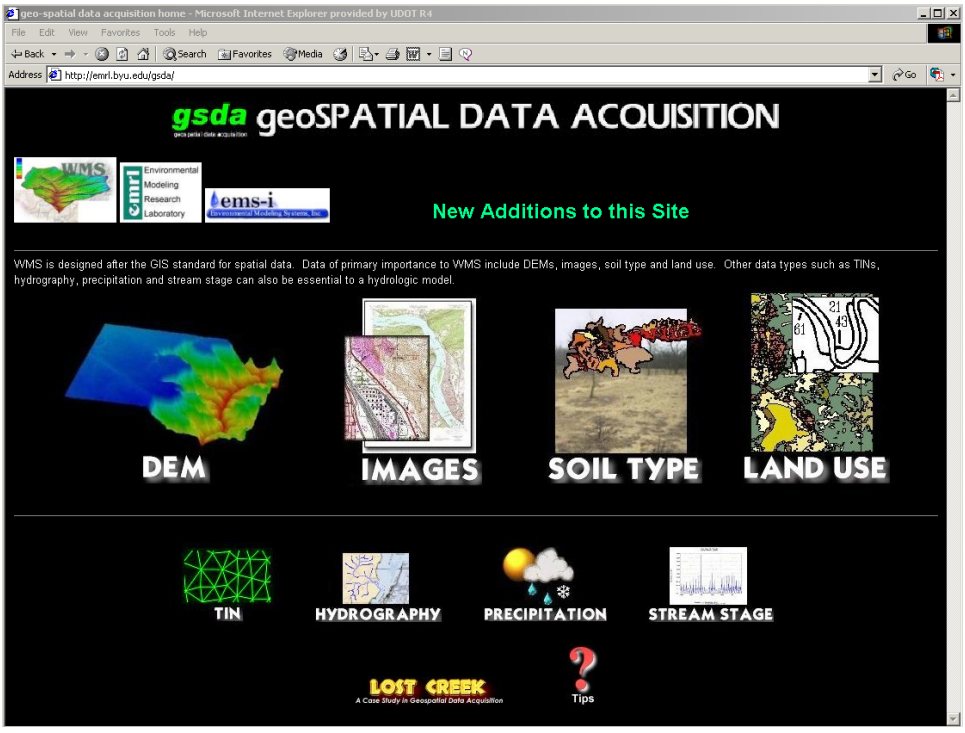
Step 1: Preparing your C Drive

Create a new folder on your C Drive called "**WMS for *Project Number***". Now open up this folder and create 5 sub folders called "**WMS**", "**DEMs**", "**Quad Maps**", "**Landuses**" and "**Soil Types**".

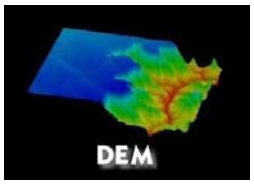


Step 2: Obtain DEMs

Open the geoSpatial Data Acquisition page and the following address: http://emrl.byu.edu/gsda/.



Click on the DEM picture.



Next Click 

.

You want the National Map Seamless Data Distribution System. Click on the "**Click Here**" button.

***The National Map* Seamless Data Distribution System**

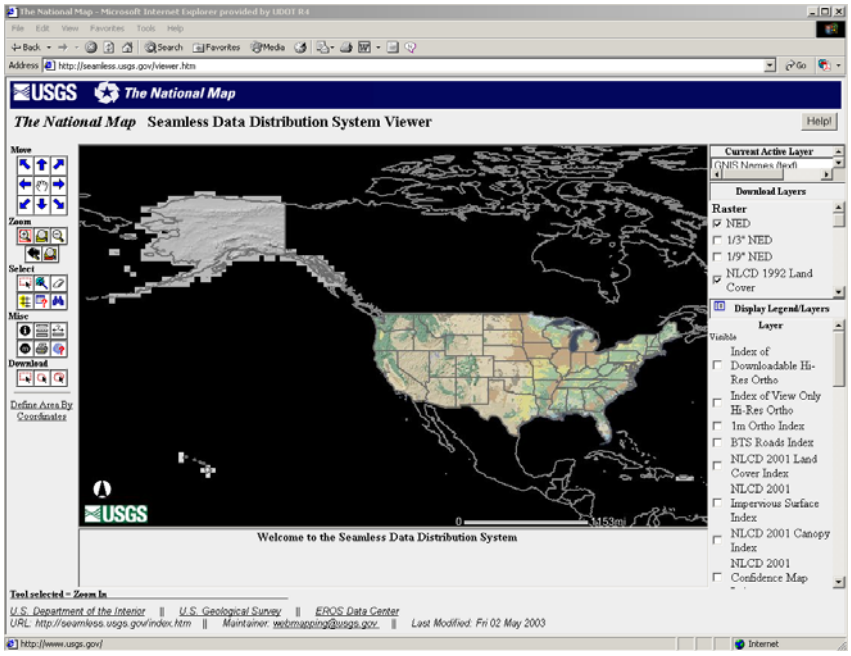
- **30 meter (and some 10 meter) data from the National Elevation Database**
- **90 meter data for all of North America from the Shuttle Radar Topography Mission**

Details:
NED and SRTM data is offered in Gridfloat, BIL, ArcGRID, and TIFF formats.
You can define a custom, seamless area to download.
The interface allows you to display various GIS layers to aid in the selection process.
Data can be downloaded in files up to 100MB in size.
COST: None

to obtain Digital Elevation data from The National Map

Click on "**View and Order Data Sets – United States Viewer**".

You now have the following screen:

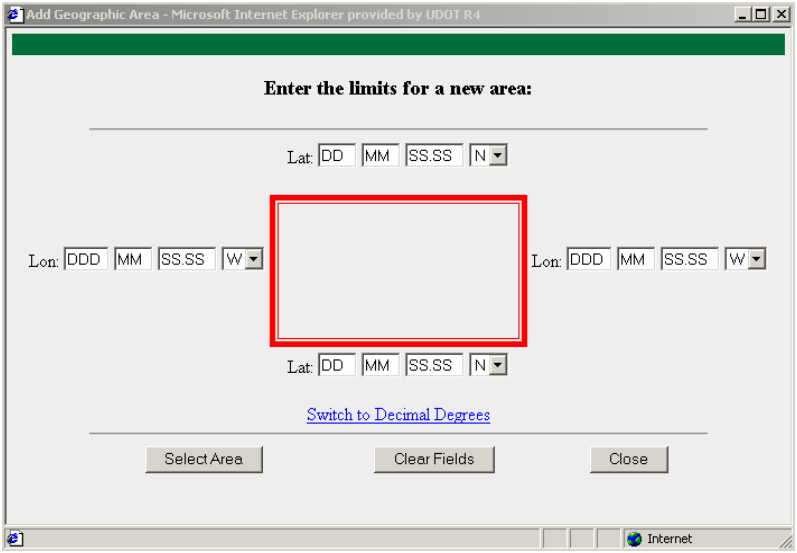


You can now download a DEM two ways.

1. You can download a DEM by typing in the coordinate systems.
   Click on "**Define Area By Coordinates**".

Click Here.

You now have the following popup window in front of you.

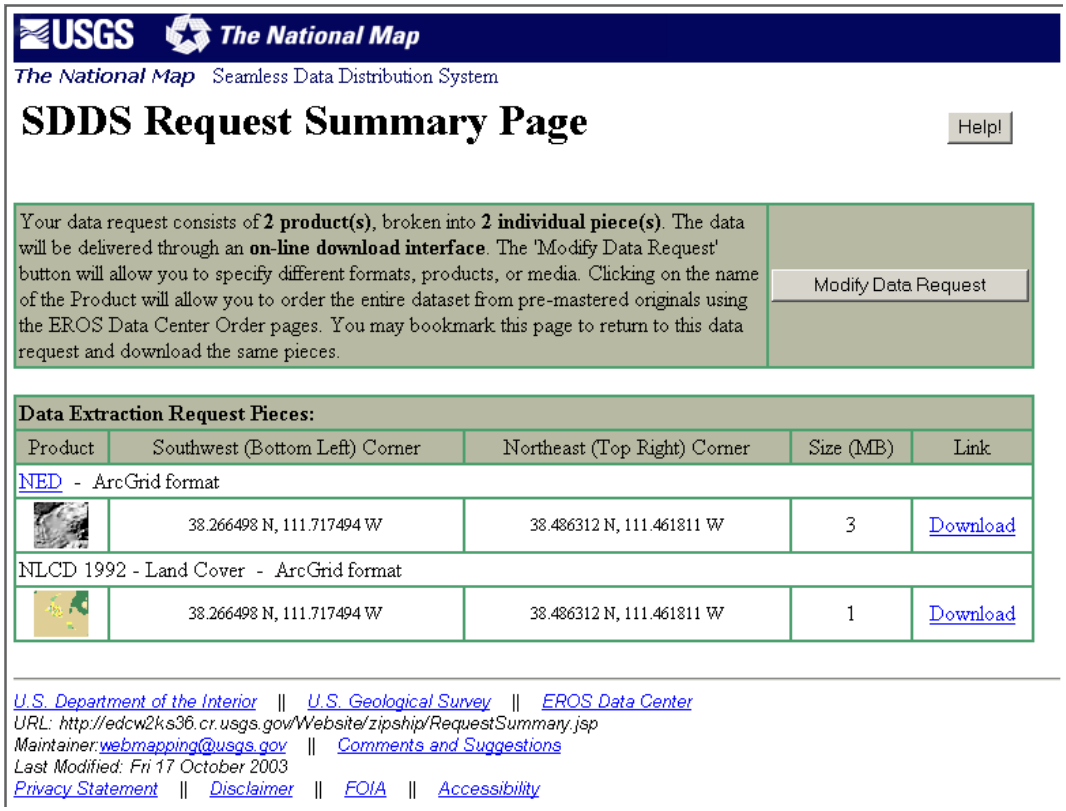


Type in the appropriate latitude and longitudinal numbers. It will then process your request. This will take a few seconds to process.

2. You can download a DEM by zooming in to the appropriate location. The curser automatically is on the "**zoom in**" tool. Zoom in on Utah on the national map. Then zoom in to your location. Click on the "**Download fence**" to select the area of DEM you want to use in your analysis.

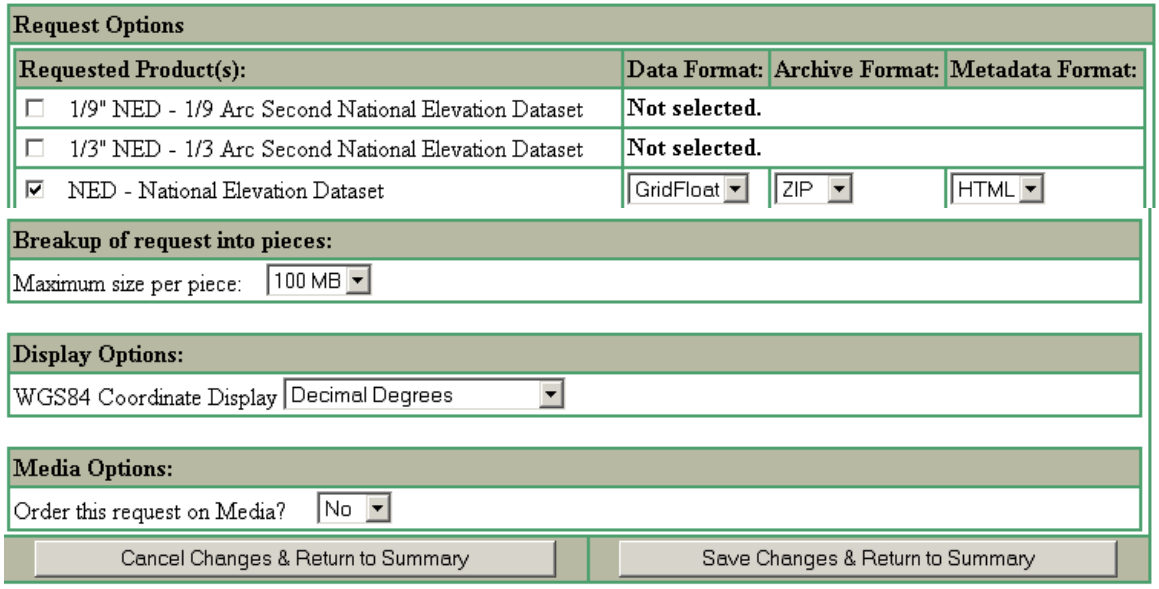
It will then process your request. Once again, this will take a few seconds to process.

You will have the following window appear on your screen.



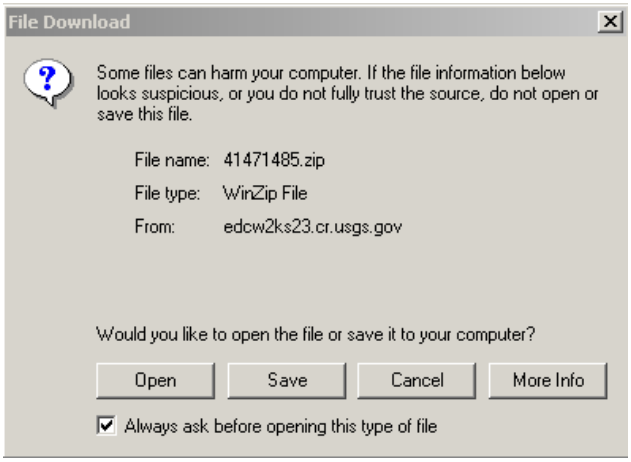
You will need to click 

. You need to select only the "**NED – National Elevation Dataset**". Change "Data Format" to "**GRID FLOAT**", and leave the "Archive Format" as "**ZIP**" and "Metadata Format" as "**HTML**".



Leave everything else on this page the same and click on "**Save Changes & Return to Summary**" button.

Click "**Download**" This will extract the data and create an archive file for you (ZIP).



Change the name and directory on save dialogue box. Save in your recently created "**DEMs**" folder.

Use Window Explorer to find the zipped file….Double click it, and use Winzip to upzip the file. This will create several files. Make sure that these are saved to your "**DEMs**" folder.

Step 3: Obtain Quad Maps

Goto the following website: http://nrwrt1.nr.state.ut.us/cgi-bin/quadview.exe?Startup . Locate the appropriate maps. More than likely, your project will need more than one quad map. Do the following for each quad map you need.

Click on your first quad map. Scroll down the page and right click on the following files and "**Save Target As**" to your "**Topos**" folder.

```
Collarless DRG Image in TIF Format:    q3222.tif
World file for Collarless DRG:         q3222.tfw
```

This is all the information you need to use the NFF Regression Equations. You can open **WMS** and insert the information we have gathered already, since NFF and TR-55 need this same information to work.

Step 4: Open WMS and insert quad maps, DEMs, and CAD drawings

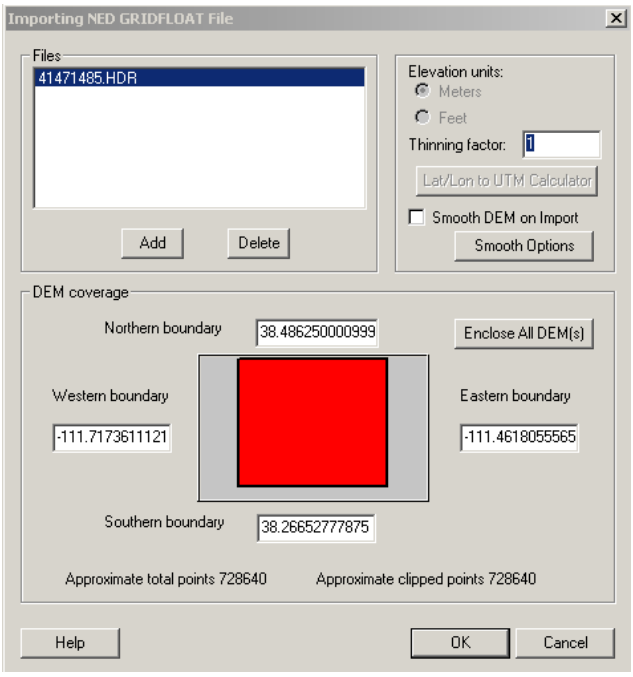
Start **WMS**

Select "**Terrain Data Module**"  from the modules pallet.

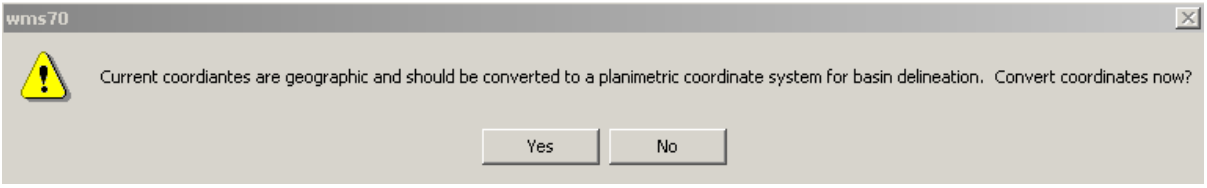
Click on "**Open File**"  .

Find your ***.HDR** file you unzipped in your "**DEMs**" folder. Open.

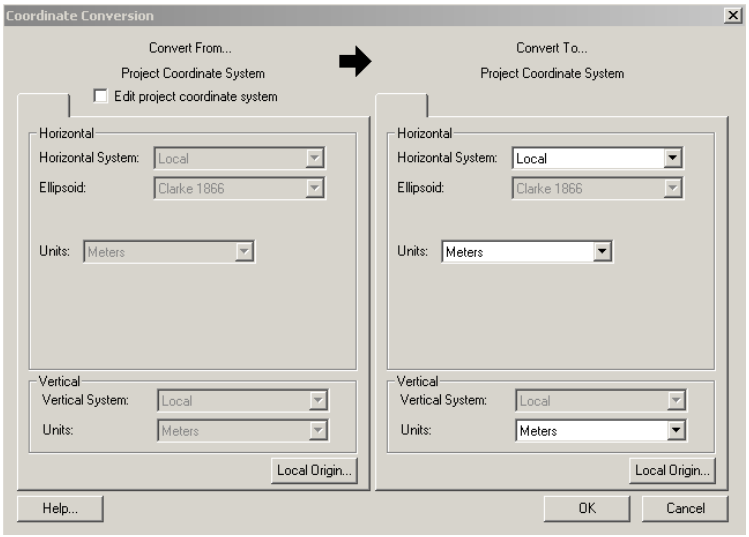
The following window will popup. Just click "**OK**".



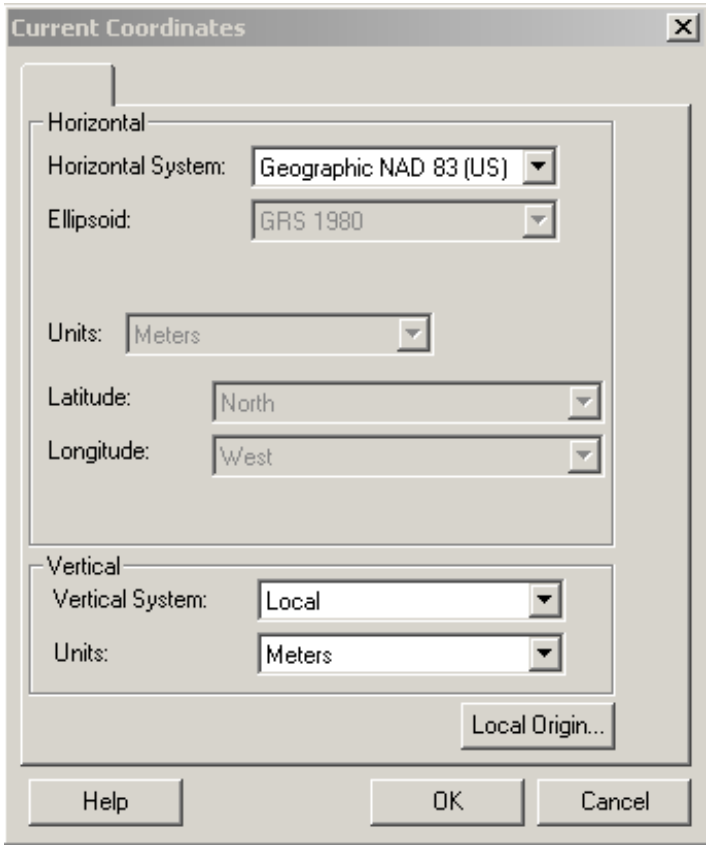
Then click "**Yes**" on the next popup window.



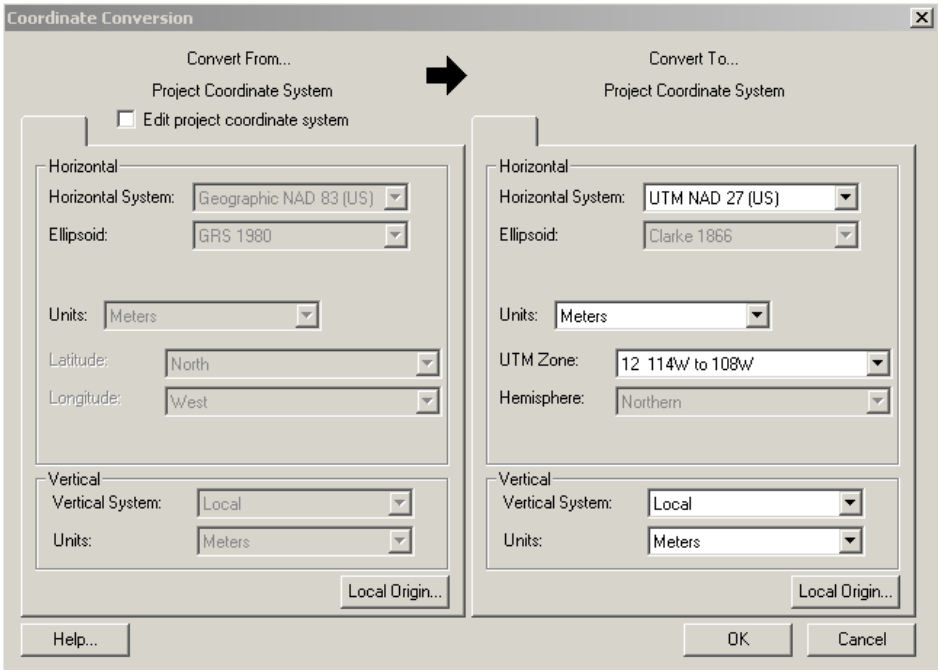
When the next popup window appears, click "**OK**". We will convert the coordinates another way.



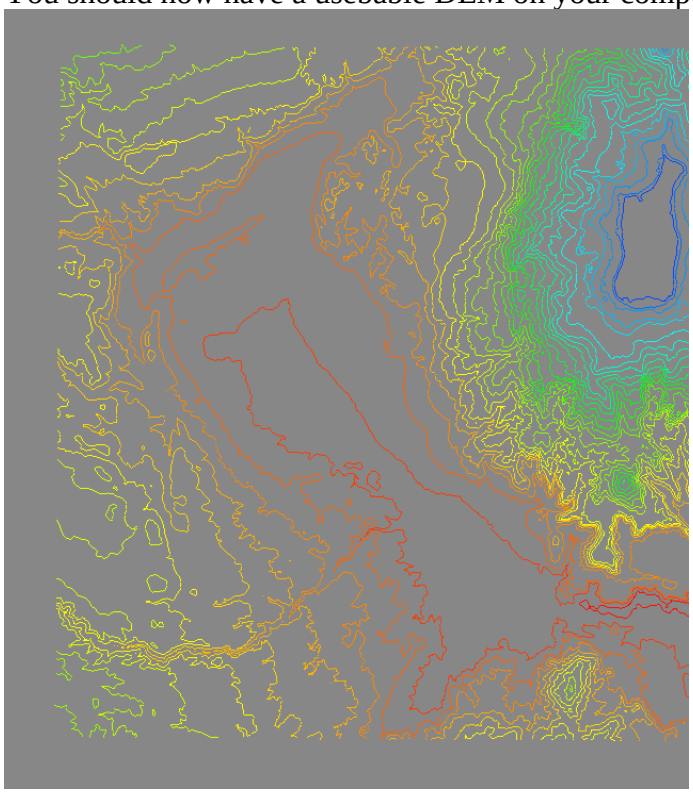
Now go to the "**Edit**" pull down menu. Choose "**Current Coordinates…**" The DEMs are imported in Geographic NAD 83 Coordinates. Leave all "**Units**" on "**Meters**" since the quads are imported in metric units also. Change "**Horizontal System**" to "**Geographic NAD 83 (US)**". Click "**OK**".



Now you need to convert the DEM file to UTM NAD 27 to be useable with USGS 7.5 minute quad sheets. Go to the "**Edit**" pull down menu and choose "**Coordinate Conversion…**". Set "**Horizontal System**" to "**UTM NAD 27 (US)**". Make sure all "**Units**" are in "**Meters**" and the "**UTM Zone**" is "**12 114W to 108W**". Click "**OK**".



You should now have a usebable DEM on your computer screen.

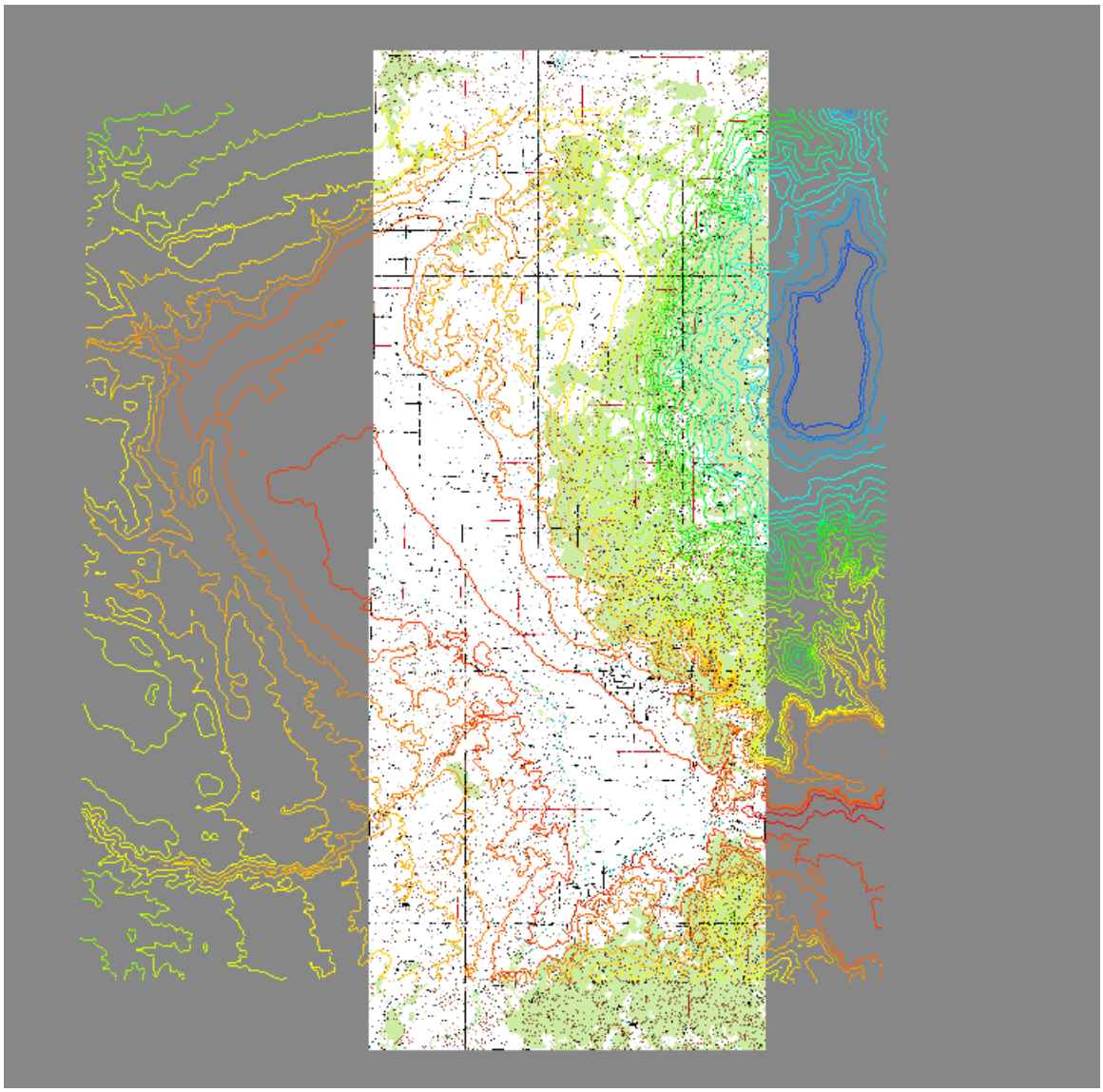


Select the "**Map Module**"  .

Goto the "**Images**" pull down menu and select "**Import…**".

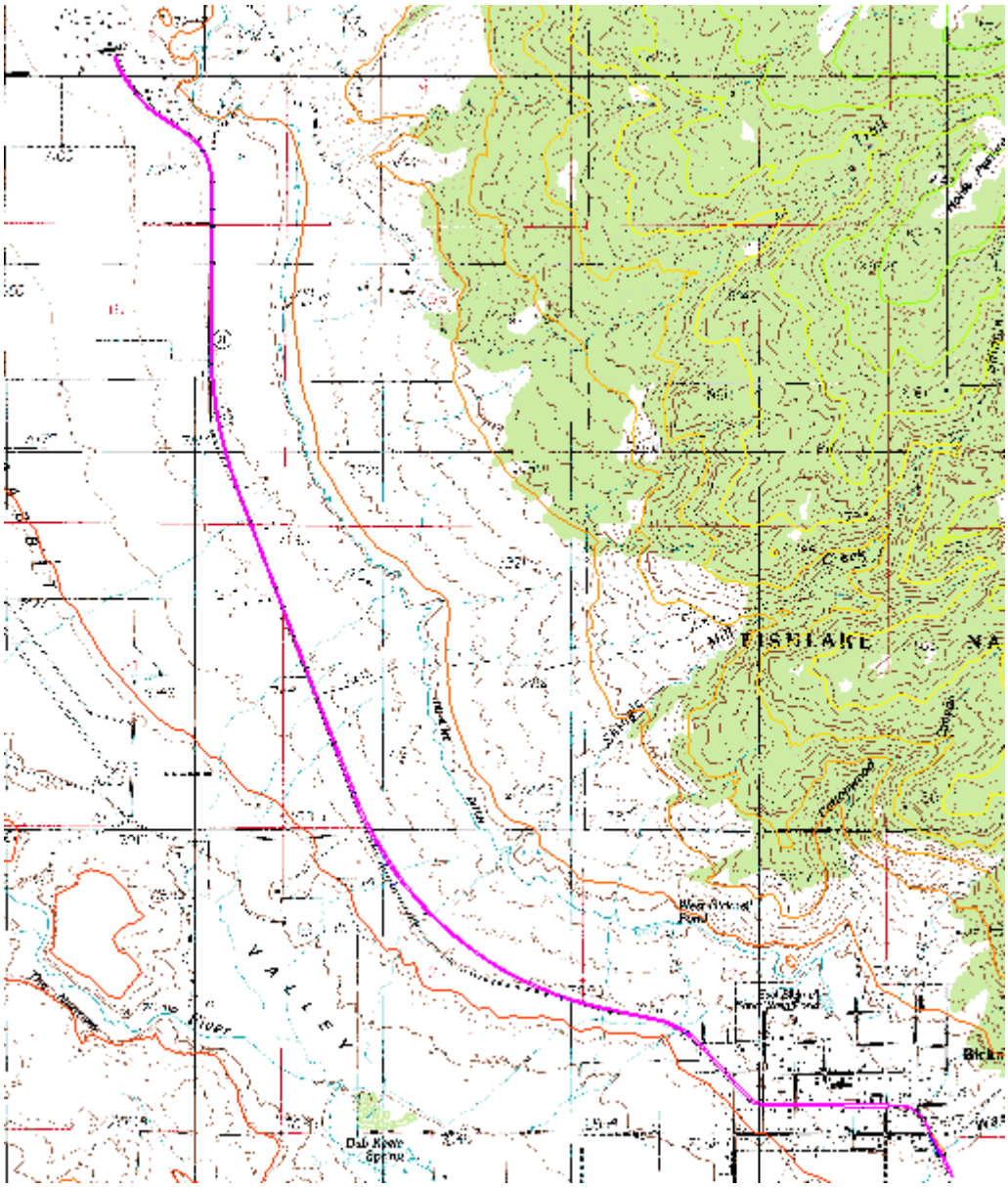
Find your ***.tif** file in your "**Topos**" folder. If you have more than one, import one at a time.

You should now have your quad maps and DEMs on the WMS screen.



You now need to import a CAD drawing into your **WMS** file. Your orginal Microstation Drawing needs to be saved as another name. Now you need to convert the coordinates to metric and to situate your drawing in the right location matching it up with your quad map coordinates. Once this is done it needs to be saved as a ***dxf** file.

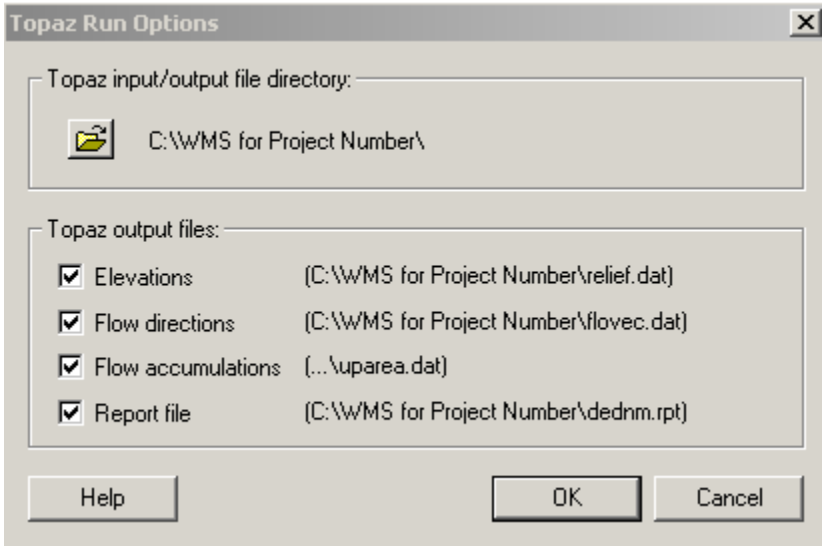
With your "**Map Module**" still clicked  , go to the "**Open**" button  , and open the ***.dxf** file. You should now see your roadway design on the WMS screen.



Now you are ready to calculate your Basin Area and other pertinent information.

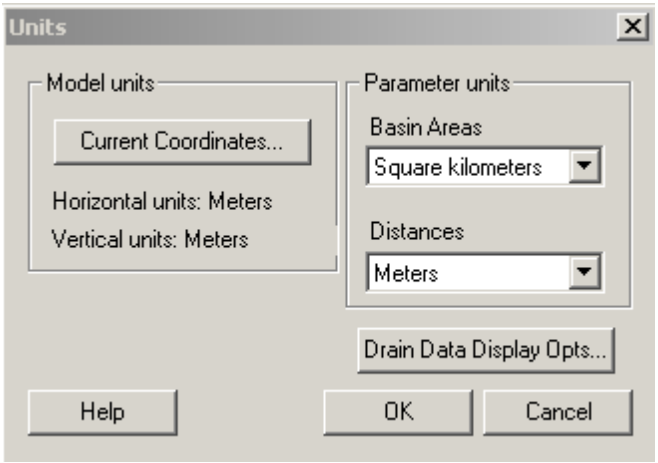
Step 5: Calculating Basin Areas, etc.

Click on the "**Drainage Module**"  . Goto the "**DEM**" pull down menu and select "**Compute TOPAZ Flow Data…**". Save data to your "**WMS for Project Number**" folder.



Click "**OK**".

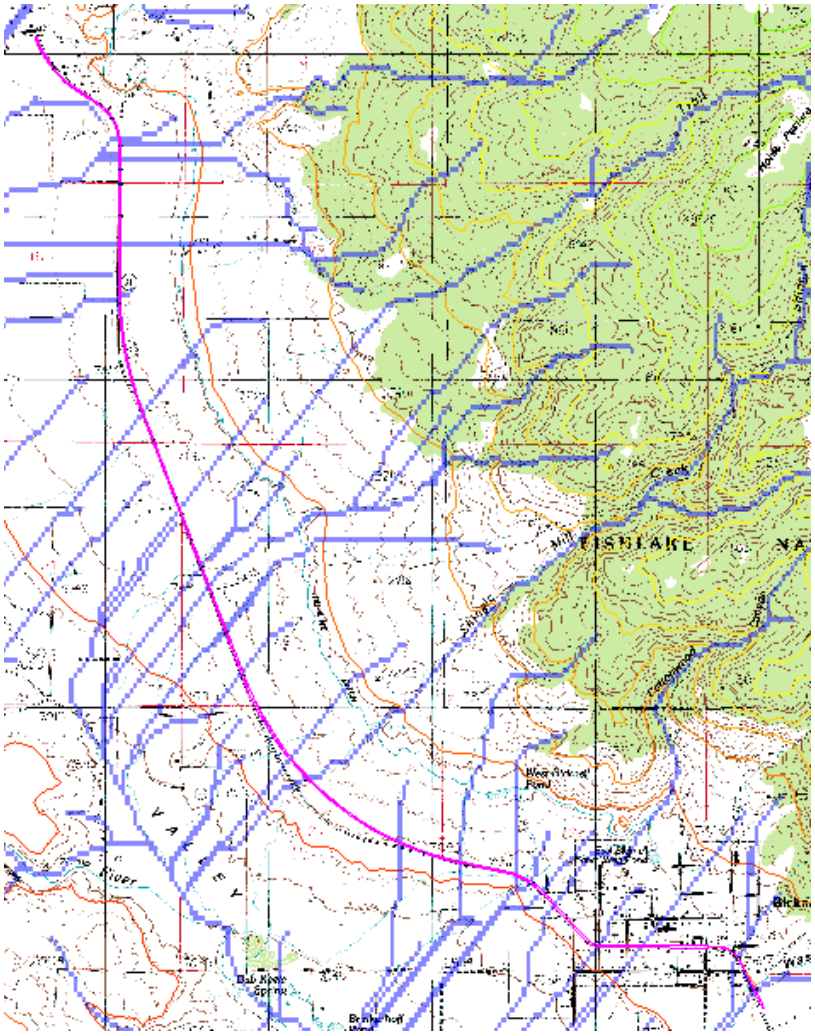
Change "**Basin Areas**" to "**Square kilometers**" and "**Distances**" to "**Meters**".



Click "**OK**"

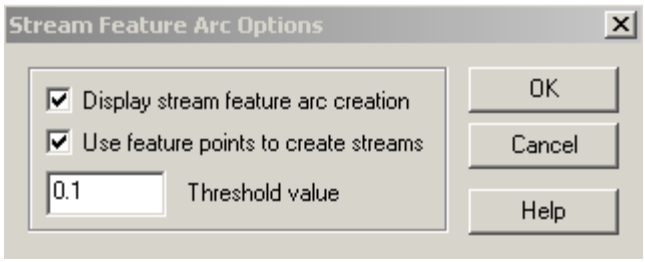
The Model Wrapper will run. When it is finished, click "**Close**". This will provide the flow lines for the many basins in your project. If you want more flow lines, goto the "**Display**" pull down menu and select "**Display Options…**" Select the "**DEM**" tab and next to the "**Min Accumulation For Display**" you can type in a number. By default, the

number is "**1.0**". If you put in "**0.1**" you will see more flow lines. If you put "**5.0**", you will see less flow lines. Input a number that is best for your project. Your screen should show something like the following:



You now need to place outlet points on your screen. Select the "**Drainage Module**"  , then select the "**Create Outlet Point**" button  . Zoom in on your flow lines next to your roadway and place outlet points. For this workflow, only one outlet will be placed.

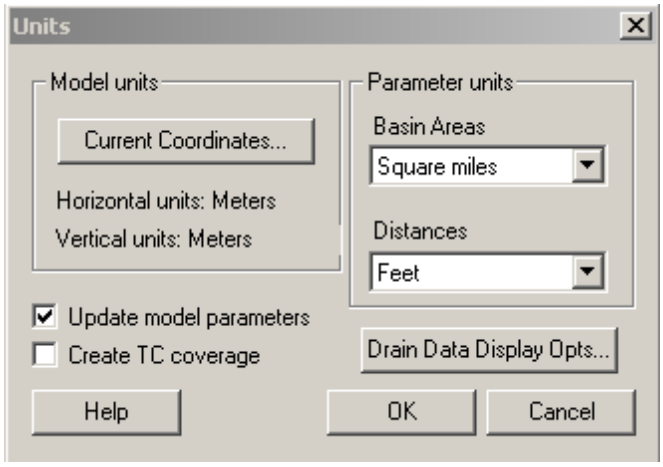
Now zoom out using the "**Frame**" button  . Still in your "**Drainage Module**", goto the "**DEM**" pull down menu and select "**DEM -> Stream Arcs…**" Turn on both "**Display stream feature arc creation**" and "**Use feature points to create streams**". Leave "**Threshold value**" at "**0.1**". Select "**OK**".



Now select "**DEM**" pull down menu, then select "**Define Basins**".

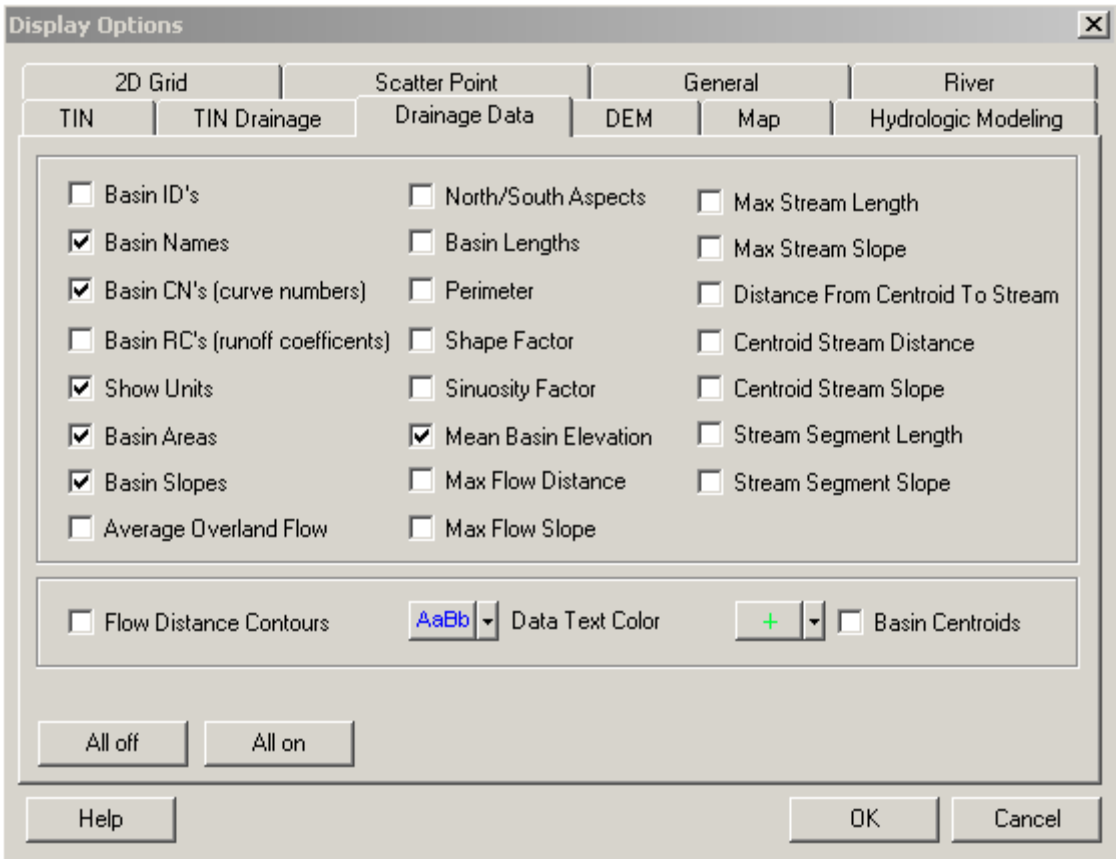
Next, select "**DEM**" pull down menu, then select "**Basins -> Polygons**".

Next, select "**DEM**" pull down menu, then select "**Compute Basin Data**". Now we can change to the following:

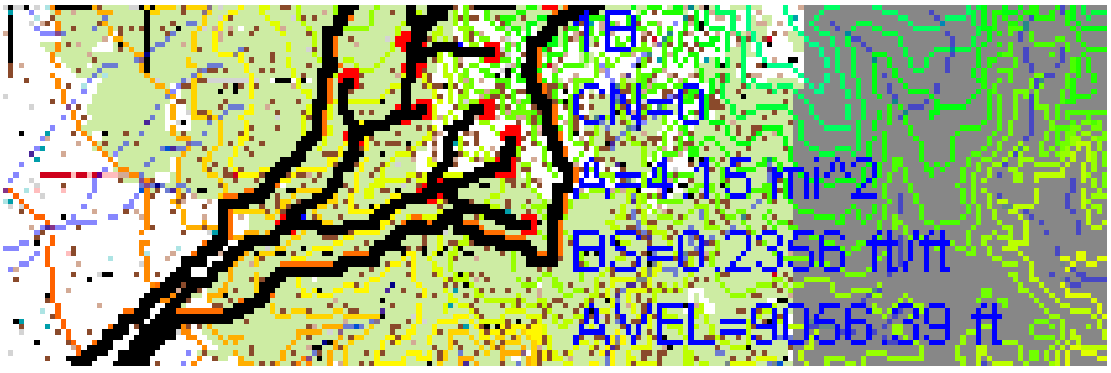


We need to have the units as such for **TR-55**. If you were using **Rational Method** you would need to have acres and feet. Click "**OK**".

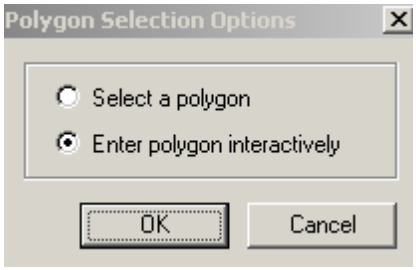
Goto the "**Display**" pull down menu and select "**Display Options…**". Select the "**Drainage Data**" tab. Click the following:



You actually can select any of the above, but this information will give us the necessary information for TR-55 and NFF models. Click "**OK**". Now you should see some information next to the centroid of your basin.

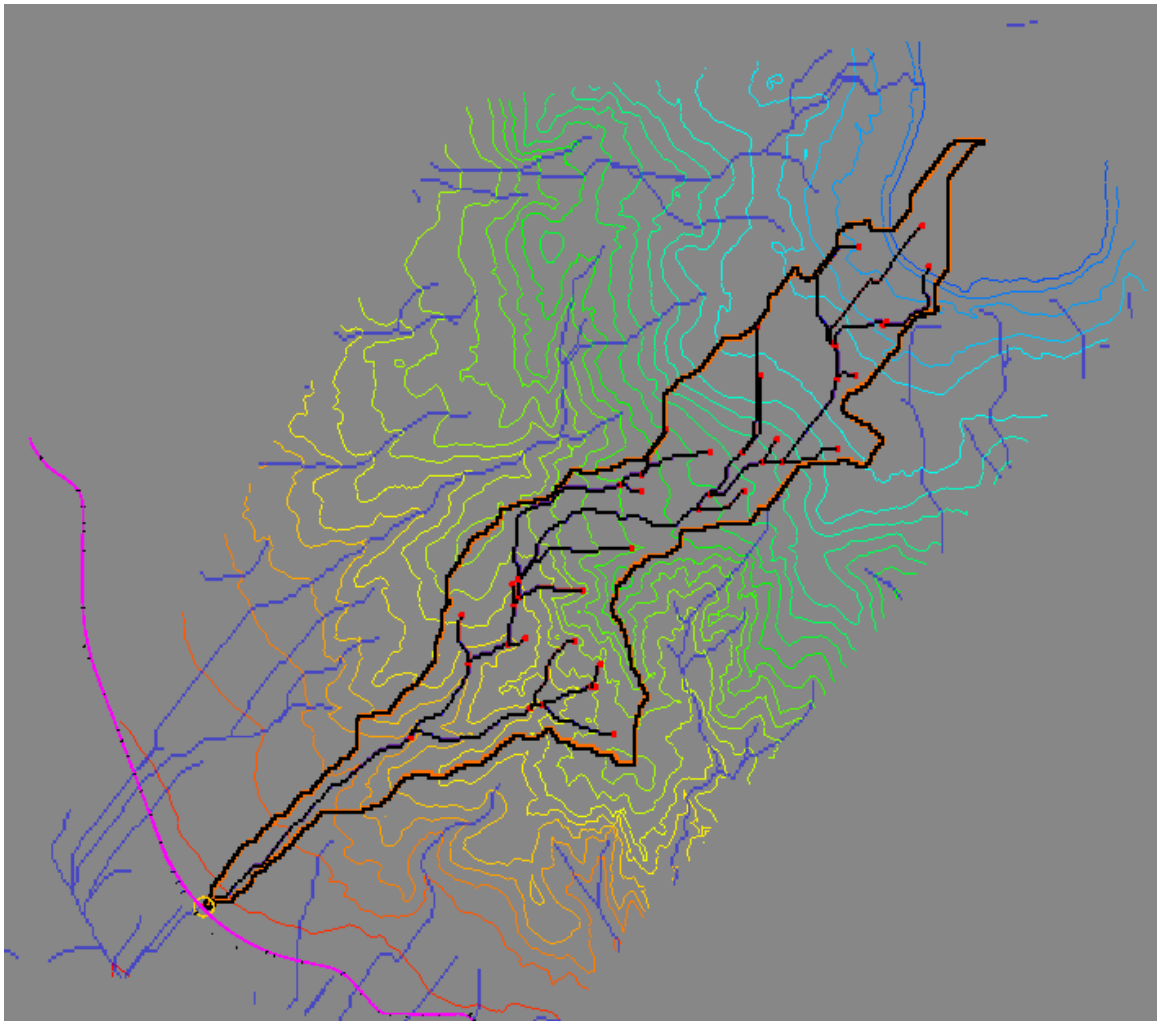


Now you will trim your DEM data to fit your basins. This will reduce the size of your file. Click on the "**Terrain Data Module**"  . Go to the "**DEM**" pull down menu and select "**Trim**". You will select a polygon interactively.



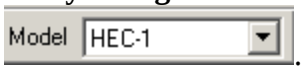
Click "**OK**"

Click points around the border of the DEM you want to keep. Double click the last point of your polygon and the DEM will be trimmed. Below, the quad maps have been toggled off in order to show you what has been trimmed.



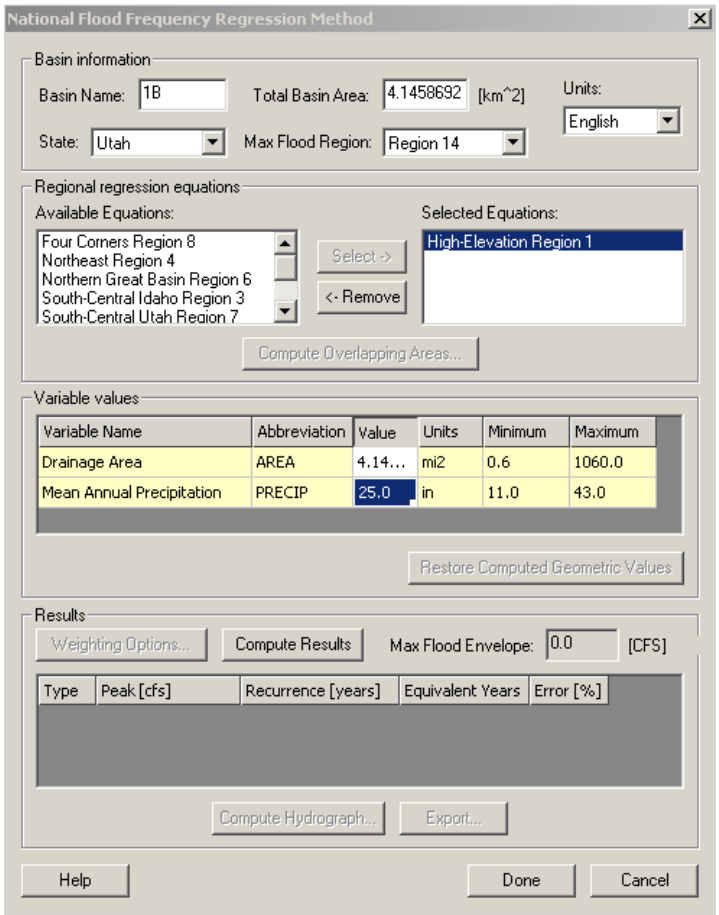
Step 6: NFF Regression Equations

If you are not doing the NFF model, skip to Step 7 to continue with the TR-55 model.

Click on the "**Hydrologic Modeling Module**"  . On the top of your screen you should see 

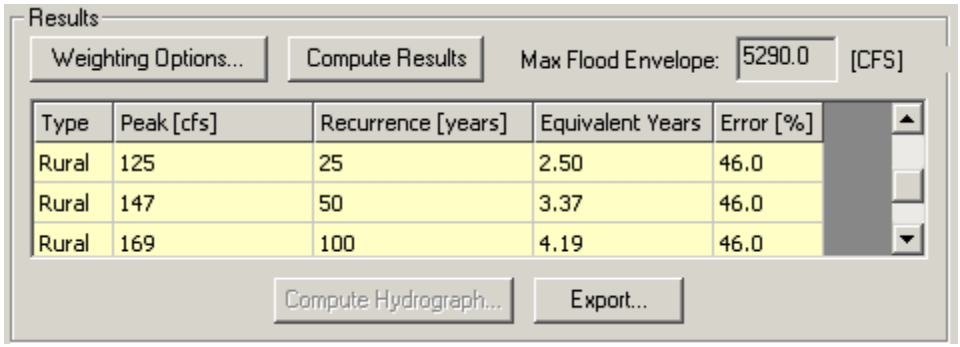
. Pull down the menu and select "**NFF**". Now click on "**Select Basin**"  . Select the basin you wish to use this model on. It should be outlined in gray. With the basin selected, goto the "**NFF**" pull down menu and select "**Run Simulation…**".

The following screen will appear.



Make sure to choose your state (**Utah**). The Max flood Region for Southern Utah will be a **14** or **16** according to the map "**Max Flood Region**" found in a folder on the O Drive called "**WMS**" that has a subfolder "**NFF**". This folder also contains the information necessary to know what Regional Regressional Equations need to be selected. The "**USGS NFF summary**" is a good reference document. Input your

Drainage Area, Mean Annual Precipitation (found on O Drive under same directory as above), and/or Mean Basin Elevation depending on what equation should be used. Click on the "**Compute Results**" button. You should now see your results at the bottom of the same screen.



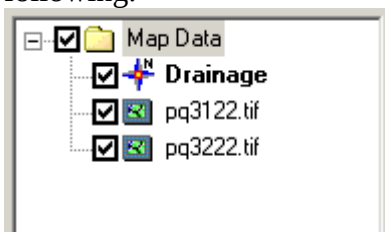
Example: You want to know the 50 year event. According to the above data the peak flow would be 147 cfs. The percentage of error is 46%. Therefore multiply 147 cfs by 1.46 to compute a one standard deviation answer. Your design would then be approximately 215 cfs.

Step 7: TR-55

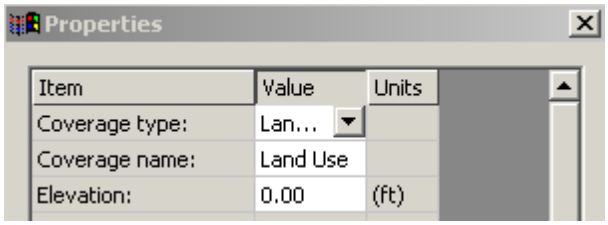
In order to have WMS compute the Curve Numbers necessary to use in TR-55, you need to import a soil data and land use data file into your program. You will need access to ArcView to do some coordinate conversion prior to importing it into WMS. Kirk has access and can convert your information quickly.

Land Use

Click on "**Map Module**"  . Look on the right side of your screen to see the following.



Right click on "**Map Data**". Select "**New Coverage**". Scroll down to "**Land Use**". Click "**OK**".



Goto http://emrl.byu.edu/gsda/ again. Select 

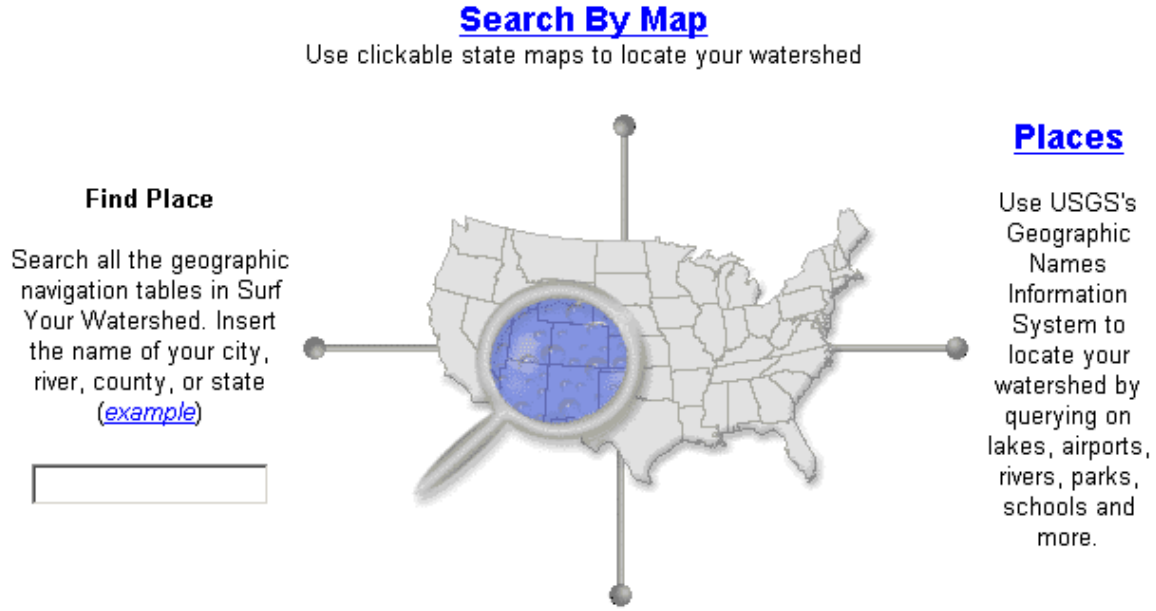
.

Click on 

. You will get your information from the EPA section. Scroll down to this section and click

to obtain the HUC number for your watershed.
The EPA provides the "Locate Your Watershed" site to help users determine their region's HUC.

Click "**Search By Map**".



Pick your state, then pick your watershed area.

If the watershed is not right, push "**Back**" and try again. Once you have your watershed, locate your USGA Cataloging Unit #. In this example it is **14070003**.

Fremont

Watershed Profile

Watershed Name: Fremont
USGS Cataloging Unit: 14070003

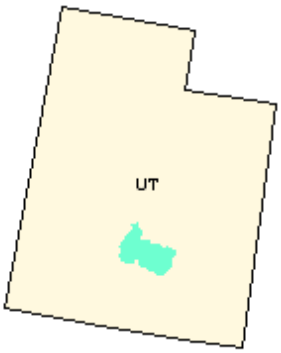
Environmental Websites Involving this Watershed

Visit the Envirofacts Warehouse to retrieve environmental information from EPA databases on Air, Community Water Sources, Water Dischargers, Toxic Releases, Hazardous Waste, and Superfund Sites Geographic searches include zip code, city, EPA Region, or county.

Citizen-based Groups at work in this watershed (Provided by Adopt your Watershed)

River Corridors and Wetlands Restoration Efforts

National Watershed Network (provided by Conservation Technology Information Center)
EXIT disclaimer



Return to http://emrl.byu.edu/gsda/ .
Select "**Land Use**" again. Select "**Obtain Land Use Data**". Then select the following:

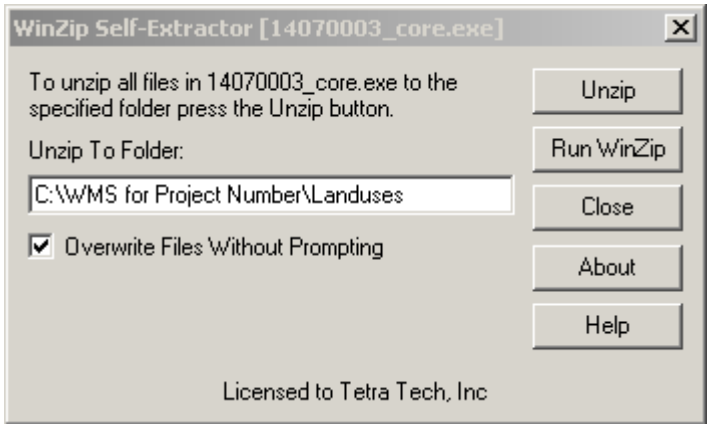
to obtain the land use data from the EPA HUC index.
The EPA offers land use shapefiles.

Scroll down to your file #. Click it. You should see the following page.

Index of /ost/ftp/basins/gis_data/huc/14070003/

Name	Last modified	Size	Description
Parent Directory			
14070003_DEMG.exe	15-Aug-2001 15:17	872K	
14070003_core.exe	25-Jul-1998 22:11	4M	
14070003_dem.exe	26-Jul-1998 10:12	2M	
14070003_pcs3.exe	19-Oct-2001 13:18	31K	

Right click the ***_core.exe** file and "**Save Target As**" in your "**Landuses**" folder. Once this is downloaded, use Windows Explorer to find this file to unzip it. Save the unzipped file in the same "**Landuses**" folder.

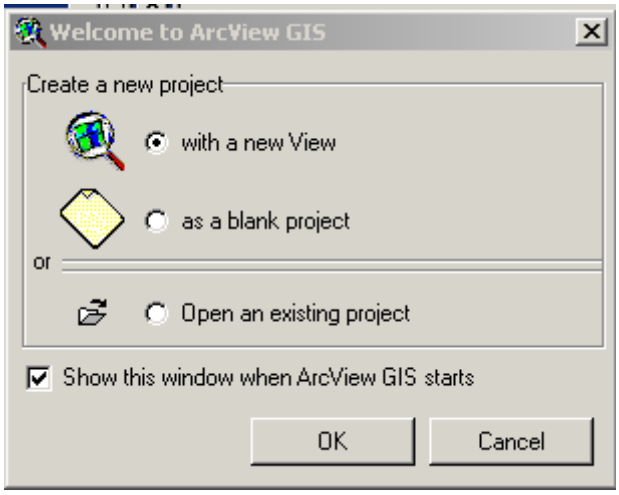


Push "**Unzip**".

Now you need to bring this in to **ArcView** to the coordinate conversion.

This procedure will be the same with the Soil data and Land Use data.

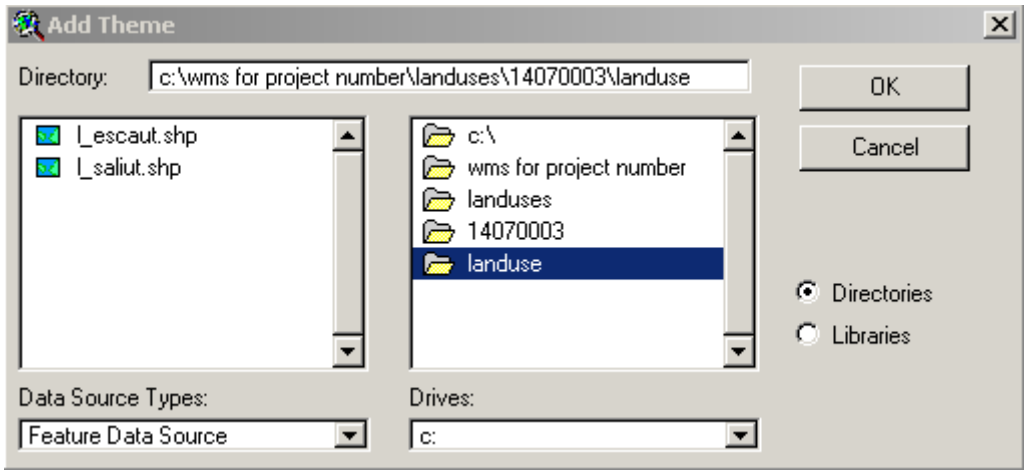
Open **ArcView**. Push "**Cancel**" on first popup window.



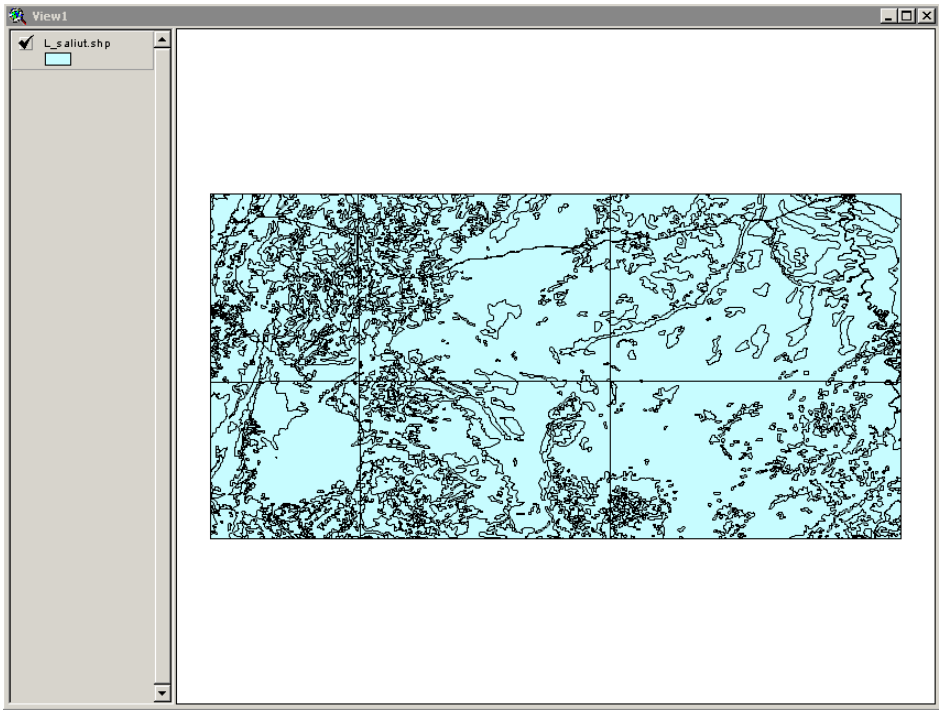
From the "**File**" pull down menu, choose "**New Project**".

Make sure "**Views**" is selected in the project dialog box and click the "**New**" button.

Enlarge the "**View 1**" window. Click on the "**Add Theme**" button  . Browse to the drive and folder where the data shapefile is found. It should be found in a similar location as shown.

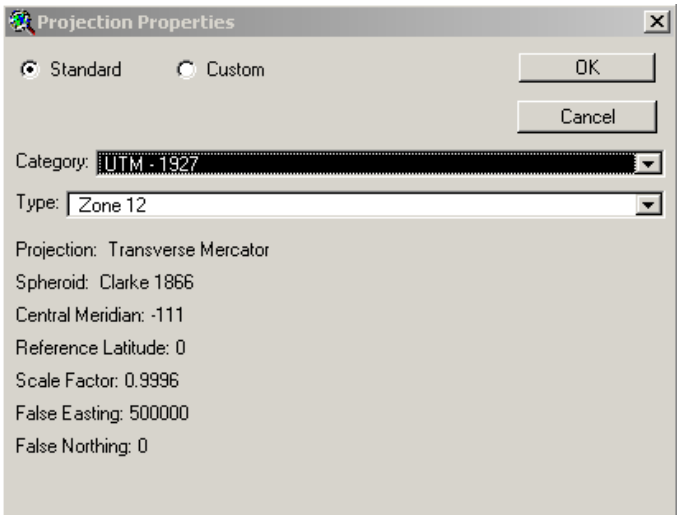


Sometimes there will be more than one land use shapefile to choose from. You will have to decide which one is right for your project. Pick one and click "**OK**". Now in your "**View 1**" window,you should see the following.

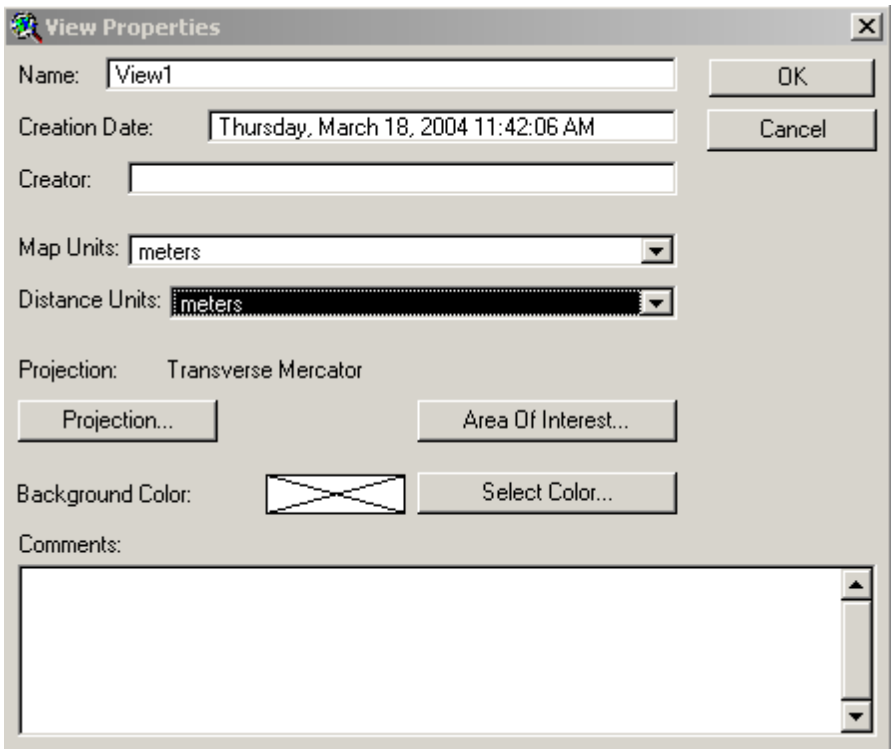


If you move your cursor around the window, you will see the coordinates in the upper right hand corner. You will now convert these to metric.

Goto the "**View**" pull down menu and select "**Properties**". A new window will appear that allows you to convert your project into metric. Press the "**Projection…**" button. The "**Category**" should be "**UTM – 1927**" like your quad maps. "**Type**" should be to "**Zone 12**". Press "**OK**".

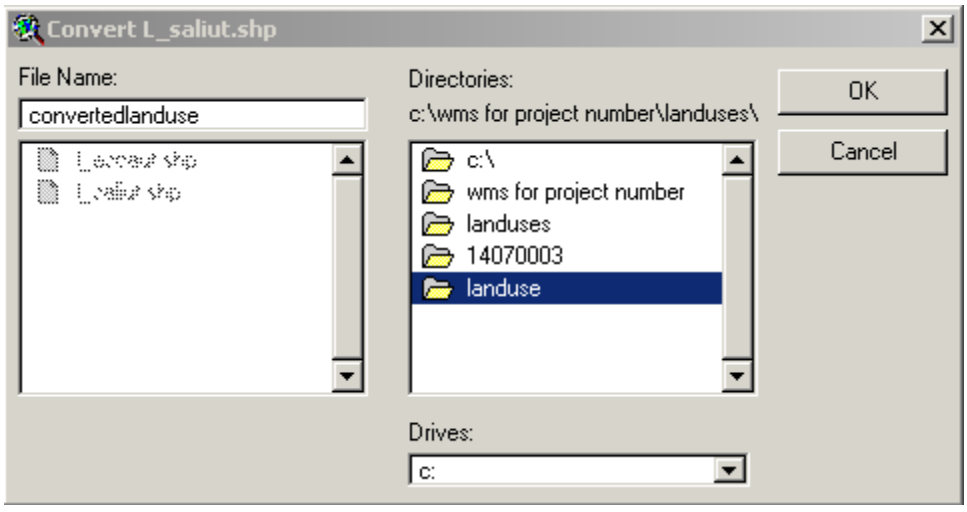


Now on your "**View Properites**" window, select "**Map Units**" to "**meters**" and "**Distance Units**" to "**meters**" also. Press "**OK**".



You should now see the coordinates in the upper right hand corner showing metric units.

Now Click on View 1. Goto the "**Theme**" pull down menu and select "**Convert to Shapefile…**". In the popup window, Save the file name as "**convertedlanduse**". Save to the correct directory. Click "**OK**".



Click "**Yes**" to save the view in the projected units. Click "**OK**" on next window popup.

Return to **WMS**. Switch to the "**Map Module**"  .

Select the "**Land Use**" coverage in the data tree to designate it as the active coverage.

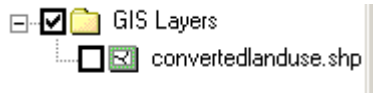
Switch to the "**GIS Module**"  .

Goto the "**Data**" pull down menu and select "**Add Shapefile Data…**". Find your "**convertedlanduse.shp**" file and open it.

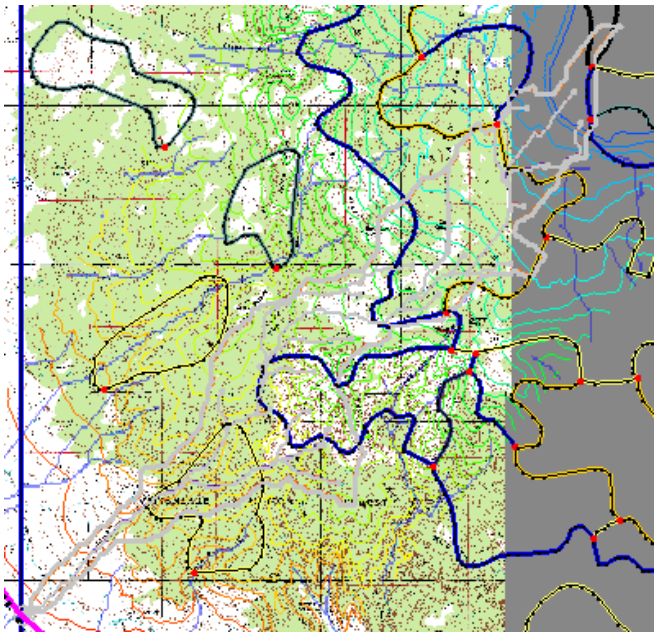
Select the "**Select Shapes**" tool  . Draw a box around the DEM extents.

Goto the "**Mapping**" pull down menu and select "**Shapes -> Feature Objects…**". Click "Next". Make sure the "**LUCODE**" field is mapped to the "**Land Use**" attribute. Select "**Next**". Select "**Finish**".

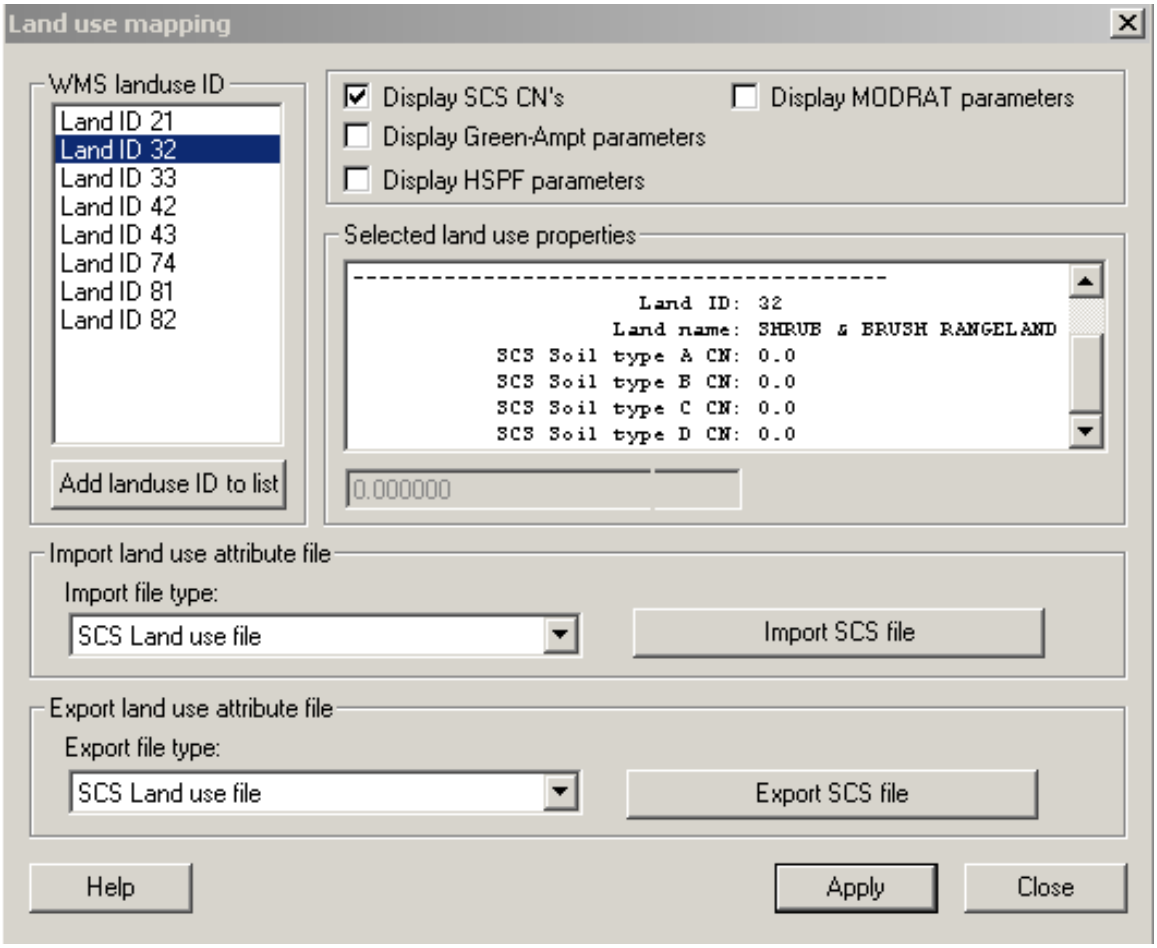
Hide the "**convertedlanduse.shp**" file in the "**GIS Layers**" by toggling off its check box.



You are now left with something like this.

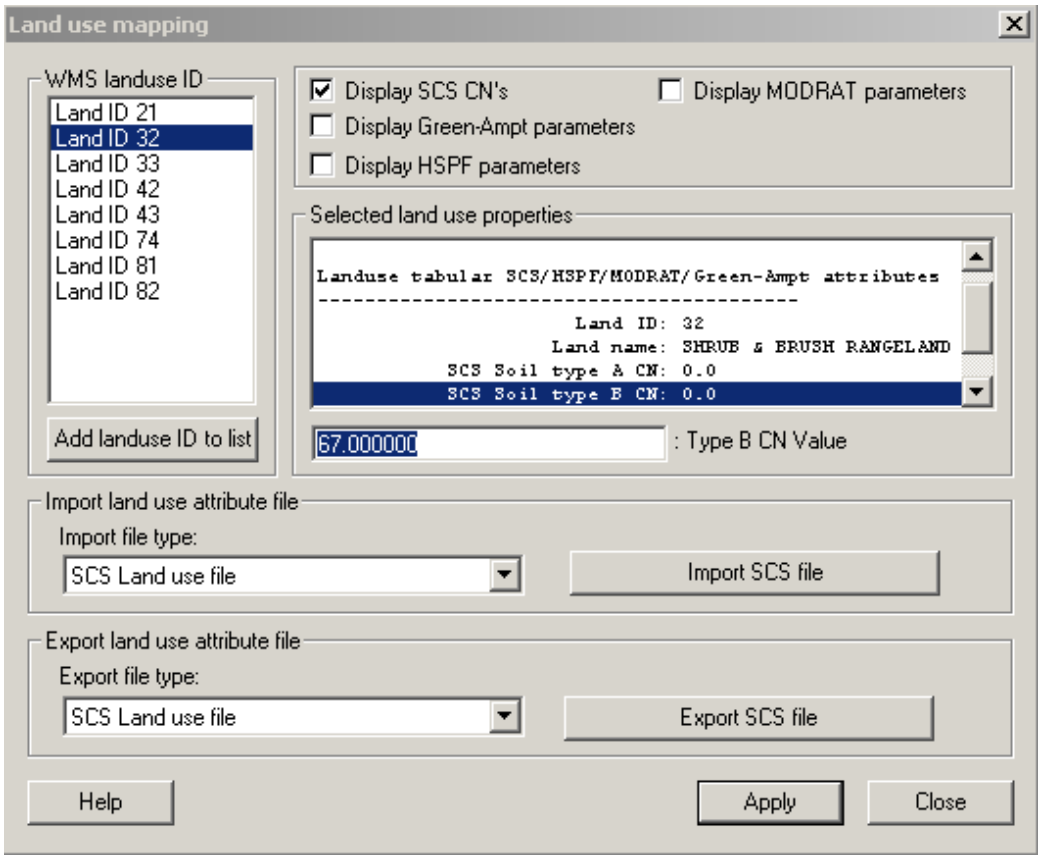


Return to the "**Map Module**"  . Double click on any of the Land Use lines. The following window will be shown.



This where you will input the CN values for the various types of Landuse IDs. The Region Hydraulic Engineer has a TR-55 Manual that has a list of CN numbers. You will have to use your engineering judgement to find the set of CN numbers appropriate for the particular Land Use. On the O Drive in the "**WMS**" folder, "**TR-55**" subfolder, there is a document that has all of these land use numbers on them and their names.

To input the CN numbers, simply highlight the "**SCS Soil type CN: 0.0**" and type in the value below.



Do this for all the "**WMS landuse ID**"s and every "**SCS Soil type**"s. Afterwards click "**Apply**".

Soil Type Data

The Soil Type Data was downloaded with the Land Use data. Find your Soil Data in your "**Landuses**" folder using windows explorer. It will be in your watershed number folder. Scroll down and find "**statsgo.shp**". This is your primary soil type shapefile containing the polygon boundaries for the soil types of your area. Find also the "**statsgoc.dbf** " file. This file contains information on the Hydrologic Soil Group and Surface Textures.

You will need to go to the O Drive under the "**WMS"** folder, the "**TR-55**" subfolder to find the **statsgoImport** excel file. Open this and follow the following instructions to join the information of the two above files.

Open **statsgoImport.xls**

Select **Enable macros**

Select "**Yes**" to open the worksheet as Read-Only
This will ensure that the original template does not get changed
i. e. to make changes, you will have to save the file with a new name.

To import the statsgo and statsgoc files

On the gray form, select the "**Open statsgo.dbf**" button

Browse for and open the "**statsgo.dbf**" file

Select the "**Open statsgoc.dbf**" button

Open the "**statsgoc.dbf**" file

To join the statsgoc HydGrp field to the statsgo attribute table

Click the "**Join**" button

This command first sorts the statsgoc table in descending order based on its COMPPCT (composition percentage) field. If multiple Map Unit Key ID's exist within the statsgoc table, then sorting the data by comppct ensures that the Join function selects the HydGrp attribute for the largest contributng area of the map unit.

Click the "**Fill**" button to make sure all records have a HydGrp entry

Enter a Hydrologic Soil Group (A,B,C, or D) or other string to use as the "filler."

Click the "**Clean**" button to convert any hybrid soil types to a single type

For example, if the entry is "B/D," then this command changes the entry to be the first group listed, "B," in this case. The Composite Curve Number calculator in WMS requires that each soil type polygon have a single soil type, A, B, C, or D, and not mixtures.

If you do not plan to use the Curve Number calculator, you can skip using the Clean button, or enter some other text as the filler.

If there are no hybrid soil types in table, skip this step.

Click the "**Save new dbf**" button

Enter a filename and click the Save button

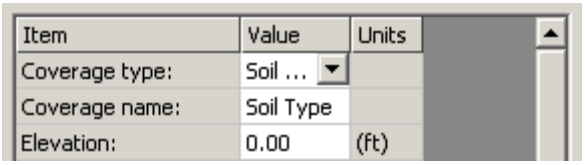
You should overwrite the original *.dbf file in order for it to remain "linked" to the *_a.shp file. **(statsgo.dbf)**

You need to once again convert the soil type data to metric units using **ArcView**. Follow the same instructions as you did with the land use data. Except you will load the "**statsgo.shp**" file and save it as "**convertedsoiltype.shp**" file in the "**Soil Types**" subfolder.

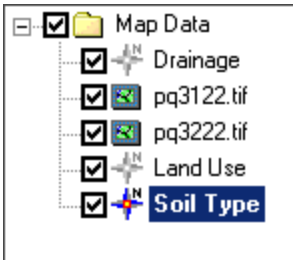
After you have converted to metric units, do the following.

Return to **WMS**. Switch to the "**Map Module**"  .

Right click on "**Map Data**". Select "**New Coverage**". Scroll down to "**Soil Type**". Click "**OK**".



Select the "**Soil Type**" coverage in the "**Map Data**" tree to designate it as the active coverage.



Switch to the "**GIS Module**"  .

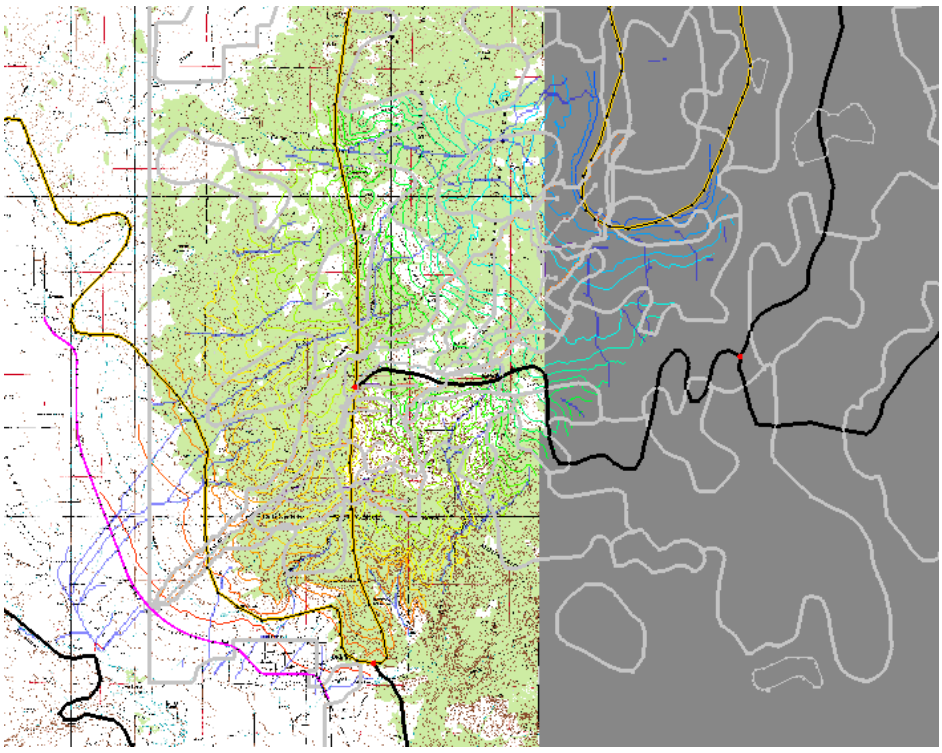
Goto the "**Data**" pull down menu and select "**Add Shapefile Data…**". Find your "**convertedsoiltype.shp**" file and open it.

Select the "**Select Shapes**" tool  . Draw a box around the DEM extents.

Goto the "**Mapping**" pull down menu and select "**Shapes -> Feature Objects…**". Click "**Next**". Make sure you see soil types A,B,C, and D are in one of the colums. Select "**Next**". Select "**Finish**".

Hide the "**convertedsoiltype.shp**" file in the "**GIS Layers**" by toggling off its check box.

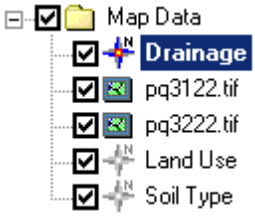
You will now have something that looks like this.



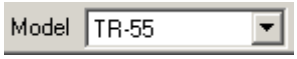
Now you have the all the necessary information to run the **TR-55**.

First you will compute your Composite Curve Number for your basin.

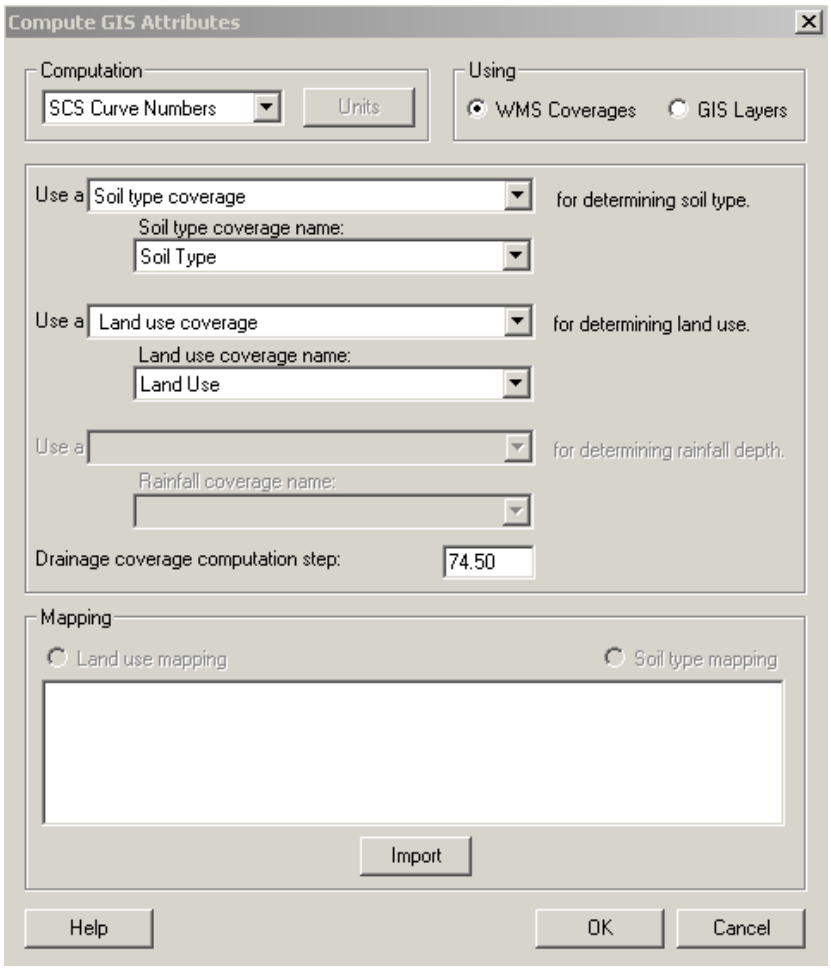
Click on the "**Map Module**"  and click on "**Drainage**" in the "**Map Data**" tree.



Click on the "**Hydrologic Modeling Module**"  . Click on "**Select Basin**"  . Select the basin you want to model. Make sure "**Model**" is selected on "**TR-55**".

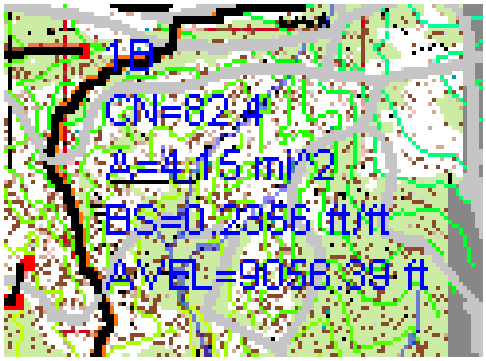


.Goto the "**Calculators**" pull down menu and select "**Compute GIS Attributes…**".



Click "**OK**".

Click on "**Drainage Module**"  . Goto the "**DEM**" pull down menu and select "**Compute Basin Data**". Click "**OK**" on the Units window. You should now see your CN number.



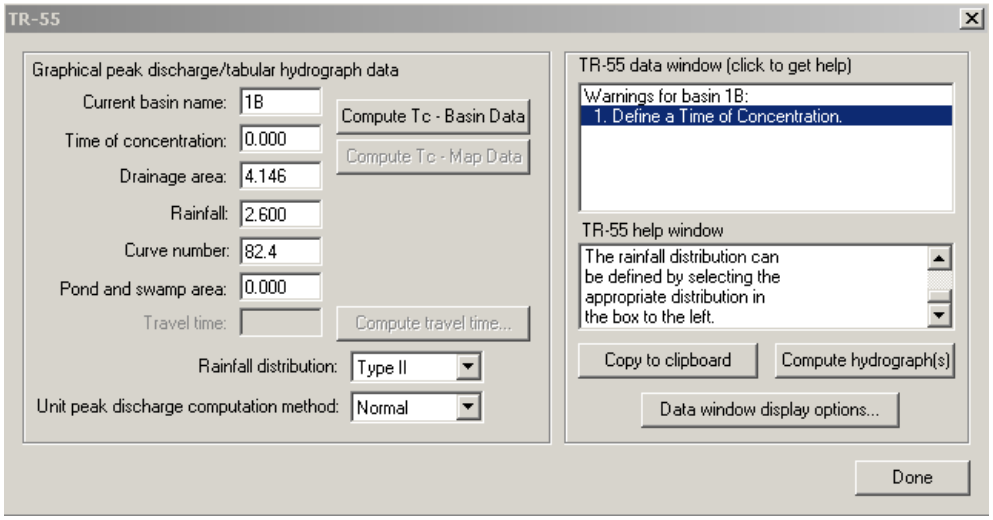
Now we can Run **TR-55**.

TR-55

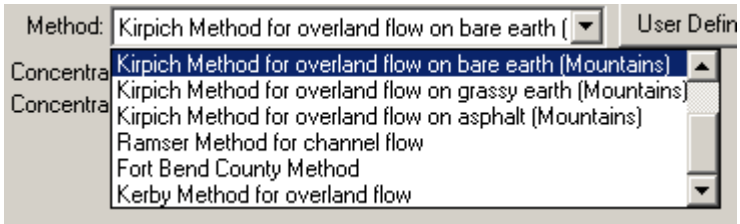
Click on the "**Hydrologic Modeling Module**"  .

Goto the "**TR-55**" pull down menu and select "**New Simulation**". Then goto the same pull down menu and select "**Run Simulation**".

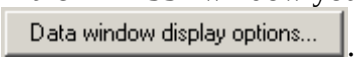
Type in your Curve Number. Using the TR-55 Manual, choose the appropriate isopluvials of 24-hr precipitation map to find the right amount of rainfall to type in. The "**Rainfall distribution**" for our area is "**Type II**" and the "**Unit peak discharge computation method**" is "**Normal**".



Now you need to click  . This program will calculate your time of concentration for you. All you have to do is pick which method the program should use. Try many of them. Find the one that best represents your basin.

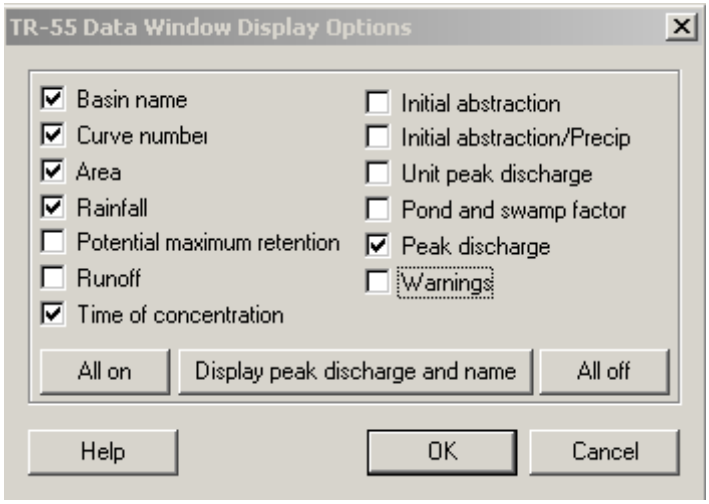


Once you have chose your "**Method**", click "**OK**".

Back in the "**TR-55**" window you are now able to see your peak discharge.
Click 

.

Toggle on the following.



Click "**OK**".

Now you can click 

and paste it to any document you want.

An Example:

Computations for basin 1B:
* Runoff curve number (CN): 82.4
* Area (Am): 4.146 square miles
* Rainfall (P): 2.600 inches
* Time of Concentration (Tc): 1.025 hours
* Peak discharge (Qp): 1498.483 cubic feet per second

You have now completed your calculations for NFF Regression Equations and TR-55.
Save your WMS project in your "**WMS for Project Number**" folder, "**WMS**" subfolder.